24 The Third Heart Sound

MARK E. SILVERMAN

Definition

The third heart sound (S_3) is a low-frequency, brief vibration occurring in early diastole at the end of the rapid diastolic filling period of the right or left ventricle (Figure 24.1). Synonymous terms include: ventricular gallop, early diastolic gallop, ventricular filling sound, and protodiastolic gallop. The term *gallop* was first used in 1847 by Jean-Baptiste Bouillaud to describe the cadence of the three heart sounds occurring in rapid succession. The best description of a third heart sound was provided by Pierre Carl Potain, a pupil of Bouillaud, who stated:

> One distinguishes therein three sounds, namely: two normal sounds of the heart and a superadded sound. . . . This sound is dull, much more so than the normal sound. It is a shock, a perceptible elevation; it is hardly a sound. If one applies the ear to the chest it is affected by a tactile sensation, perhaps more so than an auditory one. . . . In addition to the two normal sounds, this bruit completes the triple rhythm of the heart. It thus produces a rhythm of three sounds unequally distinct, and occasionally unequally distant, a rhythm which the ear seizes with extreme facility, provided that it had once perceived it distinctly. This is the bruit de galop.

Technique

The third heart sound tests the ausculatory skills of the examiner because it is often the most difficult heart sound to hear. This is caused by several factors:

1. The sound is usually of very low intensity and is easily obscured by extraneous room sounds, lung or abdominal noise, or tightening of the chest wall muscles.
2. The sound does not radiate widely and is audible only over a small area of the chest wall.
3. The usual frequency (pitch) of the sound is near the lowest level that the human ear can detect. The inexperienced ear is unaccustomed to listening for a sound of this low frequency.

All extraneous noises—radio, television, visitors, hall noises—should be excluded so that the room is as quiet as possible.

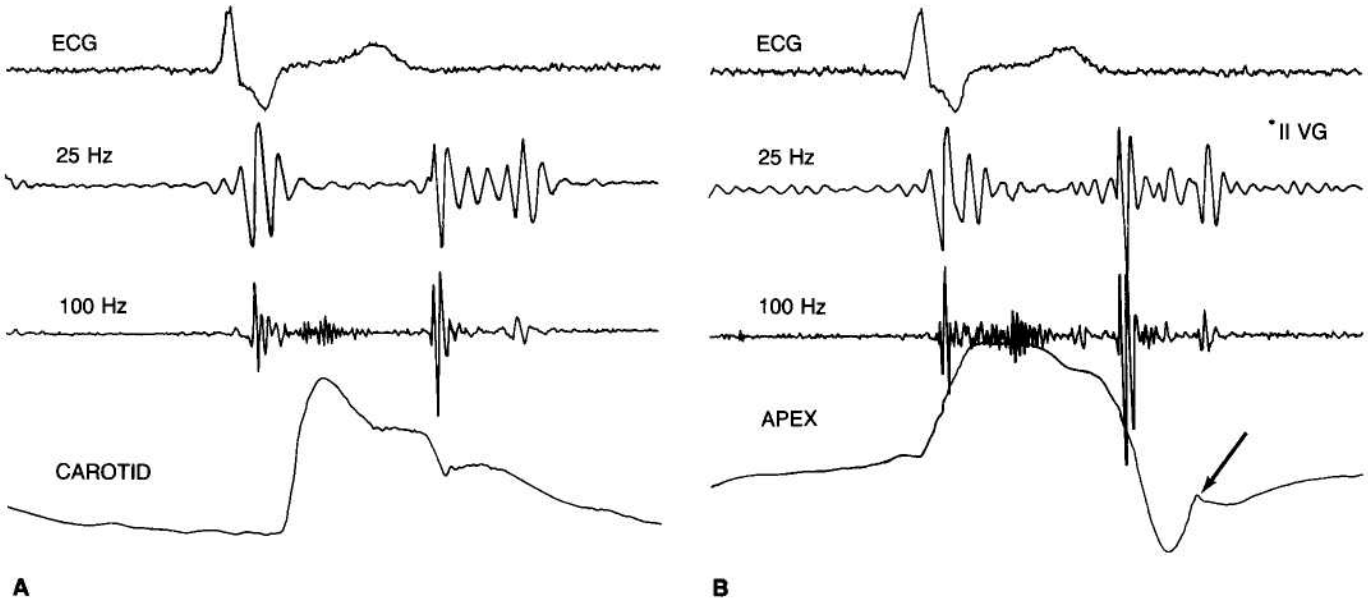

Figure 24.1
Four-channel phonocardiogram taken at a paper speed of 100 mm/sec. The top channel shows an electrocardiogram (ECG lead II); the second and third channels record from a single microphone placed near the cardiac apex. The cardiovascular sound is filtered so that the second channel records frequencies below 25 Hz and the third channel below 100 Hz. The fourth channel displays a carotid arterial pulse (left) and a tracing of the apex movement (right). The heart sounds are labeled I and II. A prominent ventricular gallop (VG) is recorded 0.16 second after the second heart sound. Note that it is recorded best on the low-frequency channel. A low-intensity, early to midsystolic murmur is also present (not labeled). The apex tracing shows a sustained systolic wave and a rapid early diastolic filling wave (arrow). The ventricular gallop occurs at the peak of the rapid filling wave. The examiner should simultaneously feel the carotid impulse and listen at the apex in order to time the heart sounds and gallop.

The bed should be elevated to a comfortable level for the examiner. The patient is examined supine and then turned to a 30° left lateral position with the left arm extended upward away from the chest and the weight comfortably supported by the left hip, lateral chest, and left arm (Figure 24.2). The left lateral position is of critical importance because the ventricular gallop is often heard only with the patient turned to the side. After the apical impulse is located by careful palpation, the bell of the stethoscope is placed lightly over the apex. The examiner then listens selectively for the third heart sound—tuning in to early diastole for low-frequency sounds while ignoring all other heart sounds and murmurs. The patient should be asked to exhale and suspend respiration temporarily in order to provide maximal silence to listen. The bell of the stethoscope is then glided around the apical and lower sternal area seeking for a left ventricular gallop. Simultaneous palpation and inspection of the apex is useful; however, a third heart sound is rarely palpable or visible when it is not audible.

A right ventricular third heart sound is an uncommon finding heard in association with right ventricular dysfunction from a variety of causes. It is usually heard best while listening along the right or left lower sternal edge, in the epigastrium, or rarely over the jugular veins. An inspiratory increase in its intensity identifies a right ventricular gallop. This diagnostic feature may be absent, however, when right ventricular distention or failure prevents inspiratory augmentation of venous return.

The third heart sound is a very low-frequency vibration, in the range of 25 to 50 Hz, and has a dull, thudding quality. At times it may be difficult to tell if it is an actual sound or more of a sensation imparted to the ear of the listener. When intense, a few after-vibrations may add to its duration and suggest a short diastolic murmur. Techniques that increase venous return or the size of the ventricular cavity—recumbent position, elevation of the legs, exercise, squatting, volume expansion—augment the intensity of S_3. Conversely, the sound becomes softer or disappears with standing, diuresis, hemorrhage, or dialysis.

Basic Science

During ventricular contraction, the mitral and tricuspid valves are closed, and atrial pressure rises (V wave) from the continuing influx of venous blood into the atria. In early diastole, when ventricular pressure falls below atrial pressure, the atrioventricular valves open wide, and the blood rapidly drains from the atria (Y descent) into the ventricles. The ventricles quickly become distended, moving toward the chest wall, until the elastic distensibility of the ventricular wall is reached and the rapid inflow of blood is checked. At the termination of this early diastolic filling period, a third heart sound may occur (Figure 24.1). The genesis of this sound is controversial. Previously, it was thought to be an intracardiac sound arising from vibrations in the valve cusps or ventricular wall as diastolic inflow suddenly decelerated. Recent studies, however, have shown that the third heart sound is loudest *external* to the left ventricular cavity, implying that the sound is not radiating from an intracardiac source. Possible explanations include impact of the ventricle against the inner chest wall or a sound originating within the ventricular apex due to sudden limitation of longitudinal expansion.

Figure 24.2
Technique of patient examination for a ventricular gallop. The patient has been turned to a 30° left lateral position. The examiner is palpating the apical impulse while listening with the bell of the stethoscope applied near the apex.

Factors that seem to relate to the presence and intensity of the third heart sound include age, atrial pressure, unimpeded flow across the atrioventricular valve, rate of early diastolic relaxation and distensibility of the ventricle, blood volume, ventricular cavity size, diastolic momentum of the heart, degree of contact (coupling) with the chest wall, thickness and character of the chest wall, and the position of the patient.

Clinical Significance

Children and adults up to age 35 to 40 may have a normal third heart sound. The explanation for this "physiologic S_3," which is identical in timing and frequency with its pathologic counterpart, is unknown. Before age 40, the significance of the third heart sound must be judged by the presence or absence of significant heart disease. After age 40, a third heart sound is usually abnormal and correlates with dysfunction or volume overload of the ventricles.

Any cause of *ventricular dysfunction,* including ischemic heart disease, dilated or hypertrophic cardiomyopathy, myocarditis, cor pulmonale, or acute valvular regurgitation, may qualify. Myocardial ischemia without ventricular dysfunction or volume overload is not a cause of an S_3. The presence of an S_3 is the most sensitive indicator of ventricular dysfunction.

Any cause of a significant increase in the *volume load* on the ventricle(s) can cause an S_3. Examples include valvular regurgitation, high-output states (anemia, pregnancy, arteriovenous fistula, or thyrotoxicosis), left-to-right intracardiac shunts, complete A-V block, renal failure, and volume overload from excessive fluids or blood transfusion.

Although the third heart sound is a very important clue to heart failure or volume overload, it does not appear until the problem is relatively far advanced. In some patients, for reasons that are not clear or because of chest size, obesity, or lung disease, an S_3 may never be heard despite severe hemodynamic impairment. Therefore, the *absence* of a third heart sound cannot be used to exclude ventricular dysfunction or volume overload. In addition, the intensity of the third heart sound is influenced by several factors and correlates only roughly with the clinical status of the patient.

The third heart sound must be differentiated from other diastolic sounds. Competing possibilities include: splitting of the second heart sound, an opening snap of the mitral or tricuspid valve, a diastolic click related to mitral valve

Table 24.1
Comparison of Ventricular Gallop with Other Diastolic Sounds

Sound	Location best heard	Interval after A_2 (sec)	Pitch	Miscellaneous
Ventricular gallop	Apex	0.10 to 0.20 (usually 0.14 to 0.16)	Very low	See text.
Split S_2	Upper left sternal border	0.02 to 0.06	Medium to high	Split varies with respiration.
Opening snap	Lower left sternal border or apex	0.06 to 0.12	Medium to high	Associated murmur of mitral stenosis. Loud S_1 usually present.
Mitral valve prolapse	Lower left sternal border	0.06 to 0.08	Medium to high	Associated systolic click(s) and/or murmur.
Pericardial knock	Apex	0.09 to 0.12	Medium to high	Usually loud and palpable. Associated jugular venous findings of constriction.
Tumor plop	Apex	0.08 to 0.13	Low	May vary with position. Associated loud S_1. Diastolic murmur may be heard.
Summation gallop	Apex	Depends on PR interval and rate	Low	Often louder than S_1 and S_2. Cannot be distinguished from loud S_3.
Atrial gallop	Apex	Depends on PR interval and rate	Low	Close to S_1. Often palpable. Higher pitch than S_3.

prolapse, a tumor "plop" from a left atrial myxoma, a pericardial knock, a summation gallop, and an atrial gallop. The distinguishing features of each of these sounds are listed in Table 24.1. With experience, the third heart sound should not be confused with other diastolic sounds because of its very low pitch and late timing relative to the aortic closure sound.

References

Aubert AE, Denys BG, Meno F, et al. Investigation of genesis of gallop sounds in dogs by quantitative phonocardiography and digital frequency analysis. Circulation 1985;71:987–93.

Craige E. Gallop rhythm. Prog Cardiovasc Dis 1967;10:246–64.

Harvey WP, deLeon AC. The normal third heart sound and gallops. In: Hurst, JW, Logue RB, Rackley CE, Schlant RC, Sonnenblick EH, Wallace AG, Wenger NK, eds. The heart, 5th ed. New York: McGraw-Hill, 1982;224–31.

Ozawa Y, Smith D, Craige E. Origin of the third heart sound. II, studies in human subjects. Circulation 1983;67:399–404.

Potain G. Du bruit de galop. Gars d'Hop 1880;53:529–31.

Reddy PS, Meno F, Curtiss EI. The genesis of gallop sounds: investigation by quantitative phono- and apexcardiography. Circulation 1981;63:922–33.

Shah PH, Jackson D. Third heart sound and summation gallop. In: Leon DF, Shaver JA, eds. Physiologic principles of heart sounds and murmurs. New York: American Heart Association, 1975;79–84.